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To: Dr. L. S. Harrow Date: September 7, 1960

From: S. Solomon

Subject: Biology of Bentonite.

## I. INTRODUCTION:

This report covers selected papers found in the literature of the past ten years which are concerned with the biological action of bentonite. Since reports concerning bentonite are few, the biological effects of the related substances, talc and kaolin, are also considered for suggestive data. In evaluating health hazards, it is necessary to look at many possible pharmacological effects, such as acute toxicity, synergism and antagonisms to other pharmacological agents, antigenic properties, chronic effects, and others. Only in two areas, the production of respiratory pathology and liver pathology has bentonite been involved as a pathologic agent. It will be seen that the reports of these effects probably do not have very much meaning in terms of a bentonite hazard resulting from smoking cigarettes using this material as an humectant.

## II. RESPIRATORY HAZARDS:

If dust particles of a great many types are inhaled in adequate concentration, there occurs a series of reactions between the dust particles and the animal.(1) The particles impinge on the cellular lining of the lung across which gaseous exchange takes place. Some of these particles will be passively moved to the small conducting airways, the bronchiales, where by ciliary action, they will be removed. Other particles will be engulfed by specialized cells, macrophages. They can either be moved to the bronchiales and be eliminated by the cilia as with free dust particles, or they can accumulate in intracellular and lymphatic spaces in the pleural region. When the latter occurs the dust laden macrophages (conglomerate), and became walled off somewhat by biological processes whereby an amorphous mass of gelatin-like material comes to embed them (hyalinization) and fibrous masses are laid down in and around them (collagenization If exposure is severe, tissue distruction may occur (necrosis). In any event the appearance of these particle-filled nodules gives rise to disease entities called pneumoconiosis, of which the most well known is silicosis caused by silica dusts. It is of interest that in the induction of a pneumoconiosis, small particles constitute the greatest danger since they travel the furthest down the respiratory tree.(2)



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The evidence favors the view, that at high enough concentrations, bentonite can induce pneumoconiosis. Rombola and Guardascione(2) report a number of cases of this disease among bentonite workers in the Parma district (Italy). The bentonite concerned contained about 30% free silicon dioxide as vitreous silica and as the mineral betacristobalite. They found a good correlation between the intensity of dustiness and the frequency of pneumoroniosis. The intensity of the danger appeared to be far more important than the duration as shown by the following facts. 1. Miners of bentonite had a lesser frequency of the disease than did workers in processing and refining plants. Dust counts were higher in the latter. 2. In comparison of two plants, the disease was more frequent in the plant with the higher dust hazard. 3. In the plant with the higher dust hazard, the work duration was shorter than in the other, before onset of the symptoms.

It has been reported that intratracheal injection of bentonite solutions results in pneumoconiosis in rats.(3) As pointed out (see report by Solomon on XIII Int. Cong. of Indust. Health) the doses given were massive. Furthermore, pathology has been found to be induced by talc(4) and by kaolin (4, 5, 6, 7,). As with the experiments on rats, a high dust atmosphere or high dosages of the substances has been required to produce effects. The cases reported occurred in people working as miners or in industries where these substances were used.

III. SOME OTHER EFFECTS OF BENTONITE:

Wilson has reported that a diet containing 25% bentonite causes marked changes in the liver characterized by, 1. fatty liver, 2. fibrosis, 3. pigmentation and 4. formation of hepatomas (8, 9, 10). He suggested that these results could be explained on the basis of adsorption of essential growth factors by bentonite. On diets of 0.5 to 3% bentonite, rats are unable to accumulate vitamin A added to the diet by the liver (11, 12). On a basal diet and bentonite alone, liver weight was down although there was no reduction in body weight. One may again note here the high concentrations which were used.

In isolated frog hearts, the amplitude of the beat has been restored by bentonite after the heart beat was reduced by low calcium or high potassium. It was suggested that this was a result of the high surface activity of the bentonite.(13)

IV. SOME USES OF BENTONITE AND TALC:

Despite what seems to be a health hazard, bentonite, talc, and kaolin are used in medical procedures. Thus kaolin is used

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in the treatment of chronic spontaneous collapse of the lung[14] in order to induce the laying down of fibrous tissue. It has further been shown that such treatment does not lead to detectable changes in lung function.[15] Both talc and bentonite have been used in X-ray examination of the bronchial tree.[16]

V. ESTIMATION OF POSSIBLE HEALTH HAZARD OF THE USE OF BENTONITE AS AN HUMECTANT:

The evidence is strong that chronic high level intake of bentonite by oral and respiratory routes constitutes an health hazard. Despite this apparent danger, drug companies use bentonite in various medical preparations (donnagel,[17] for example.

To evaluate the respiratory hazard, however, one should look at the dust data of smokes obtained from bentonite containing cigarettes (see Table 1). It has been found that the bentonite containing cigarettes contains no more silica or aluminum compounds in smoke than do control cigarettes, nor is the total organic content greater. Moreover upon microscopic examination of the smoke, bentonite was not detectable.[18] With respect to the biological effects discussed above, it seems reasonable, therefore, to conclude that addition of bentonite to cigarettes does not constitute any more of a health hazard than does smoking of cigarettes produced by methods now in use. The quality and health hazard may even be improved since there is a possibility that bentonite may adsorb certain compounds which are irritants.[19] Work, however, would be required to establish this latter possibility.

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TABLE 1.

COMPARISON OF CONCENTRATIONS IN EXPERIMENTAL STUDIES IN BENTONITE

| SOURCE | CONCENTRATION OF INORGANIC MATTER | REF. NUMBER |
|---|---|---|
| Diet | 25% by weight | 8, 9, 10 |
| Diet | 0.5 to 3% by weight | 11 |
| Intratracheal injection | 40 mg. in a single injection | 3 |
| Control cigarettes | 860 mmg./liter of smoke | 19 |
| Bentonite cigarettes | 674 mmg./liter of smoke | 19 |

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